Skateboarding

What would Isaac Newton think if he rode a skateboard? Being a physicist, he would not simply be enjoying the ride. Newton would be pondering the ride's relationship to his three laws of motion. When you are skateboarding, you are thinking about your ride, not inertia. However, if you were to study the mechanisms behind your skateboard and your skateboarding tricks, you would actually be more prepared to perform tricks. You would understand why your arms go the opposite direction of your legs in an aerial stunt. So let's get going. In this section we will examine several fundamental aspects of skateboarding.

- What would Isaac Newton think if he were to ride a skateboard?
- What are the fundamental differences between past and present skateboards?
- What are the forces involved in the three different types of skateboarding moves?
- What are the physics involved in a cat, or a skateboarder, dropping through the air?
- What are the energy changes as we move through various skateboarding moves?
- What can we learn about our body’s physics by analyzing video clips?

Question 1: What would Isaac Newton think if he were to ride a skateboard?

Introduction

If Isaac Newton were to ride a skateboard, we assume he would be thinking about his three laws of motion. The first law of motion has to do with inertia. Objects in motion tend to stay in motion, and objects at rest tend to stay at rest unless acted upon by an unbalanced force. The second law of motion relates to the equation F = ma. This means that the force created by an object is directly related with the object's mass and acceleration. The final law of motion has to do with action and reaction forces. Every force has an equal and opposite reaction. This activity requires you to relate skateboarding to these three laws.

Equipment Needed

1. Brain
2. Clips or video of skateboarders in action, or good skateboarders.

Procedure

In this lab, you will be watching skateboarding moves. You are going to determine three skateboarding moves or actions for each law. For example, to get a skateboard to move forward, the rider must begin to push back and down on the ground to get the board to move. This force then has a reaction force that pushes back and causes the rider to move forward.

Analysis/Questions

List your three determinations for each of the three laws. Compare yours to your classmates. Where there any you did not find? What made you omit these activities?

Question 2: What are the fundamental differences between past and present skateboards?

Introduction

There is no doubt that skateboarding has changed in the last 20 years. Skateboarders used to simply stay on the ground (flatland). Now, skateboarders are boring if all they do is stay on the ground; aerial moves are an intricate part of skateboarding as a sport. We will see how the design of the board has to do with the moves that can be performed.

Equipment Needed

1. Past and present skateboards
2. Internet access and computers

Procedure

In this lab you will be looking at old and new skateboards. To compare using the proper terms, you should access the website http://www.exploratorium.org/skateboarding/index.html. This site has vocabulary, information and diagrams on skateboards. This site shows how trucks and wheels are related and why you should care. As you look at the skateboards, see how they differ in design and construction. Can you do similar moves on the old and new skateboards, why or why not?

Analysis/Questions

1. List three things that are similar in the skateboards.
2. List three things that are different in the skateboards.
3. What types of moves are the old skateboards used for and why?
4. What types of moves are the new skateboards used for and why?
5. What simple machines are involved in the mechanics of a skateboard?

Question 3: What are the forces involved in the three different types of skateboarding moves?

Introduction

In skateboarding there are three types of moves. Flatland moves are stunts that are done entirely on the ground. Aerial moves begin on the ground and involve some type of flight in the air. Half-pipe moves involve using a half-pipe to do the tricks. As the rider is performing each of these moves, forces are acting upon their bodies and the skateboard. Recall that a force is either a push or a pull. Forces involved include the weight of the rider, weight of the board, friction, gravity, thrust, drag, lift, and the reaction forces from each of these forces.

Equipment Needed

1. Clips or diagrams of three different skateboarding types.
2. Transparencies and pens

Procedure

This lab involves making stick figures for the different skateboarding moves. Stick figures are simply a diagram of the rider and skateboard system. If you are using a clip, you do not have to do a figure for each movement, you are allowed to skip some movements. I suggest about five figures for each trick. As you do your figures, make certain to label the ground and the skateboard so you will be able to correctly identify the forces acting on the rider in the air. Once you have made your stick figures, you will merely add force arrows in the proper direction and indicating the proper magnitude for each force.

Analysis/Questions

1. Are all forces present during all the skateboarding moves? Why or why not?
2. Why should a physicist care about the forces acting on the rider and the forces acting on the board during a ride?
3. How do stick figures help you in determining what the rider is doing as they ride the board?

Question 4: What are the physics involved in a cat, or skateboarder, dropping through the air?

Introduction

An object rotating about an axis tends to keep rotating about that axis. The resistance to change rotational motion is called the moment of inertia. Angular momentum is a product of the moment of inertia and the rotational velocity of an object. To visualize, think about ice skaters; they usually end their program with a spin. Their spin begins with their arms out, and as they want to go faster, they bring their arms in towards their body. As their arms are out, they are increasing their radius of rotation therefore creating a slower spin. Their arms out is a large moment of inertia and creates a small rotational velocity. When they bring their arms in, towards their axis of rotation, they are decreasing their radius of rotation, thereby speeding up. Arms in is a small moment of inertia and a large rotational velocity. These results are a consequence of the Law of Conservation of Angular Momentum; at all times, the angular momentum must remain the same. If one goes up, the other must go down.

Equipment Needed

Internet access and computers

Procedure

1. Go to the website: http://www.exploratorium.edu/skateboarding/trick_midair_activity.html
2. Do the activity located at the website. Please do not try this on your cat a home. Make certain you watch the upper body and the lower body.

Analysis/Questions

1. Is your upper body following your lower body?
2. Name another example, not from skateboarding, of conservation of angular momentum.
3. What does this activity have to do with skateboarding?
4. Find two skateboarding moves that involve increasing/decreasing the moment of inertia therefore decreasing/increasing the rotational velocity.

Question 5: What are the energy changes as we move through various skateboarding moves?

Introduction

Due to the Law of Conservation of Energy, energy can neither be created nor destroyed. It can however be converted. This is what happens on a daily basis in our lives, and in the half-pipe for example. Energy can be converted from kinetic energy to potential energy and from potential energy to kinetic energy. In this exercise you will examine several skateboarding moves and determine the type of energy at certain moments in time.

Equipment Needed

1. Internet access and computers
2. Video clips or proficient skateboarders

Procedure

The first part of this activity involves doing the activity located at: http://www.exploratorium.org/skateboarding/trick_pump_activity.html.

Next, watch the riders to determine what they do to convert their energy. For example, in the half-pipe, the riders bend their knees and crouch while at the bottom. As they move to the slope, the riders straighten their legs. Your job is to look for other examples and determine why they must occur. Look at three tricks, one for each of the type of skateboarding moves (flatland, aerial, and half-pipe).

Analysis/Questions

1. Think of another example of energy changes in your life (or as you were a child).
2. What would happen to a rider in the half-pipe if they did not pump their legs?
3. Why is a conversion of energy in the half-pipe necessary in the first place?
4. How does this exercise relate to the cat exercise and the conservation of angular momentum?

Question 6: What can we learn about our body's physics by analyzing video clips?

Introduction

Our bodies are very complex machines. In this exercise, I hope to get you to appreciate the skill of the riders and the magnificent ability of our bodies to do what we ask of them. We have learned about Newton's three laws, about conservation of rotational momentum, and about the forces acting on a rider. Now, I ask you to combine all these thought processes into analyzing the tricks with respect to the body.

Equipment Needed

Video clips or proficient skateboarders

Procedure

In this exercise you are going to watch the riders and see what they do to their bodies to get the board to move in a certain fashion. For example, in the Ollie, riders bend down to store energy in their legs before they use their back leg to hit the back of the board. Or, you can watch what riders do to their bodies to prevent injury. For example, when landing from an aerial jump, riders bend their knees to absorb shock from the reaction force with the ground. Your task is to choose three skateboarding moves, and tell me how the body changes throughout the move and why it is necessary for these movements. Then tell me something about the body movements with respect to physics.

Analysis/Questions

1. Are their some similar movements in all three of your skateboarding moves?
2. Are their some physics concepts that are central to each of your skateboarding moves?
3. Please describe to someone how to do an Ollie simply by telling the rider what his or her body must do.
4. Please describe to someone how to do a tailspin simply by telling the rider about the physics involved in the spin.